

Introduction:

Plant resistance to disease is essential for adequate food production and provides significant reductions in farmers' use of land, water, fuel, and other inputs. Plants in both natural and cultivated environments carry inherited resistance to disease, but this resistance does not always protect them.

Plant pathogens can spread rapidly over large distances, carried by water, wind, insects, and humans, across large areas and across multiple crop species. It has been estimated that disease typically reduces crop yields each year in more developed countries, but crop losses due to disease often exceed 20% in less developed countries.

However, disease control is reasonably successful for most crops, which is achieved through:

Genetic methods: using plants that have developed good resistance to many diseases.

Agricultural methods: through farming practices such as crop rotation, use of pathogen-free seeds, appropriate planting times, plant density, and field moisture control.

Chemical methods: using insecticides.

Chapter 1: Enemies of Crops

Les ennemis des cultures

The term “plant pests” refers to all factors that have the potential to cause damage to cultivated plants, whether they are living or non-living.

1- Definition of plant diseases

Plant diseases sometimes arise due to the climate or a lack of appropriate elements in the soil, and sometimes, to a greater extent, as a result of bacteria, viruses, or fungi.

Fungi lack chlorophyll, the green pigment necessary for photosynthesis, and therefore must obtain food from other plants in order to survive, which leads to damage or death of other plants.

Fungal or viral diseases also cause crop destruction and significant losses, such as wheat rust and powdery mildew.

2- Plant pests:

Plant pests can cause plant diseases that may be infectious or non-infectious.

2.1- Infectious diseases: Caused by:

2.1.1-Animal parasites

2.1.1.1- Vertebrates

1 – Mammals

These include rodents, which are small animals that feed on grains, roots, and many other crops.

This causes significant losses, especially since they reproduce rapidly. Examples include:

Brown rats (or sewer rats)

Black rats

Garden dormice

Dormice

Field voles

Field mice

Ground voles

2-Birds

Most birds are more beneficial than harmful, and we can distinguish between two types: native birds that are born, grow, and live in the same place, and migratory birds that flee from cold weather and food shortages.

2.1.1.2 - Invertebrates:

Nematodes ouanguillules: * Worms or snakes

Mollusques:* Molluscs

Escargots: Snails millepattes*Millipedes:

Insectes:* Insects. This is the most dangerous group of animals for plants due to the large number of species and their enormous numbers.

Arachnides : * Agricultural pests (moths)

2.1.2- Parasites végétaux Plant parasites :

Phanerogams*: These are large parasites, including:

Direct parasites: when they live on the plant itself.

Indirect parasites: when it comes to wild plants (such as weeds)

Cryptogams*: These are microscopic fungi that are responsible for most plant diseases.

3.1.2-Bacteria:

Bacteria is the general name given to certain microorganisms and prokaryotes found in all environments. They are mostly single-celled.

Although less aggressive than fungi, bacteria cause many diseases in cultivated plants, such as bean blight, cherry and plum pox, dry nut buds, cucumber wilt, and pear blight.

4.1.2-Viruses:

A virus is an extremely small, molecular-sized entity that can only be seen with an electron microscope and can only develop inside a living cell.

They invade all plant tissues except meristematic tissues and seeds in general. They are incurable and can be transmitted from one plant to another by insects and even by contact. They are controlled by selecting healthy seeds and plants and by planting meristems. Viral diseases include apricot yellowing, potato yellowing, tobacco mosaic, stunted or short-node grapevines, etc.

Non-infectious diseases:

Caused by non-biological factors such as:

- *Extreme heat or cold
- *Lack of or excess moisture
- *Lack of or excess light
- *Lack of oxygen
- *Air pollution
- *Lack of food
- *Increased mineral salts in the soil, causing plant toxicity
- *Acidity or alkalinity of the medium
- *Pesticide toxicity
- *Some incorrect agricultural practices.

3- Les champignons phytopathogènes Plant pathogenic fungi:

3.1- Structure of fungi:

Fungi are generally composed of fine threads called mycelium, which is a gelatinous mass called a plasmodium (**Plasmodes**). They don't possess chlorophyll, which makes them unable to produce their own food, so they rely on other living or dead organisms for their nutrition.

There are two types of fungi:

Parasites: *They feed on living plant matter and often coexist with the host organism.

Saprophytes: Decomposers *They feed on dead plant matter such as humus and plant debris.

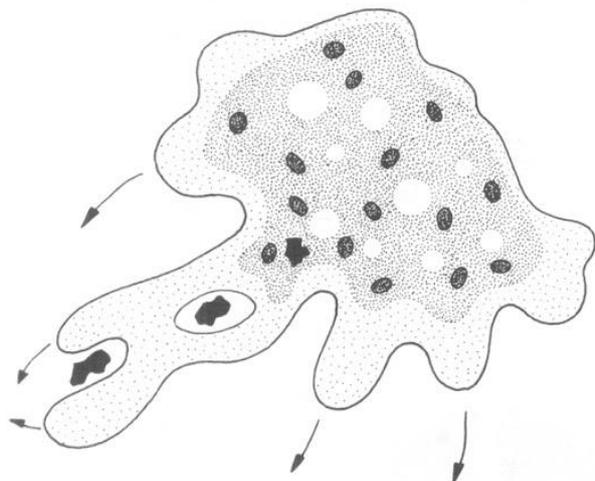
*Or both.

In any case, the mycelium threads secrete enzymes that break down organic matter and make it absorbable by the fungi.

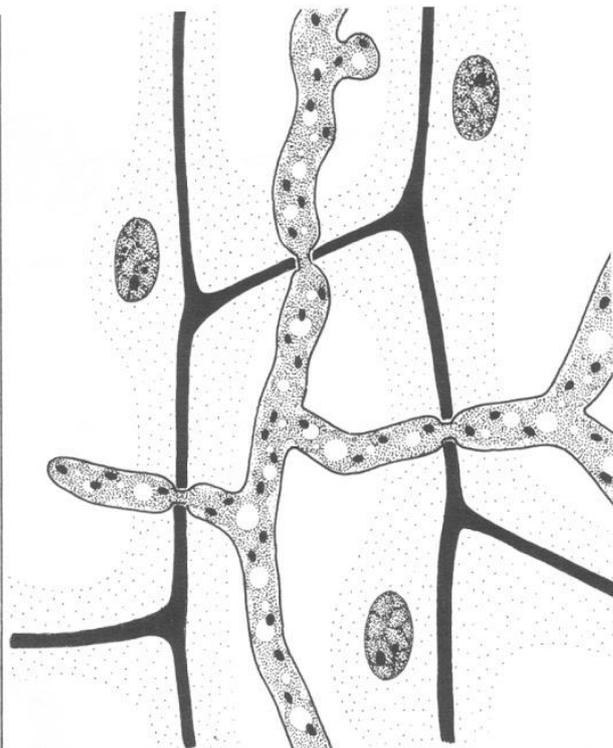
Ectophytes External parasites or on plant surfaces such as Saprophytes Mycelium threads extend on the soil surface such as . Endophytes intracellelaire or intracellular Endophytes or inside plants (between cells) and are internal parasites

** Mycelium growth:

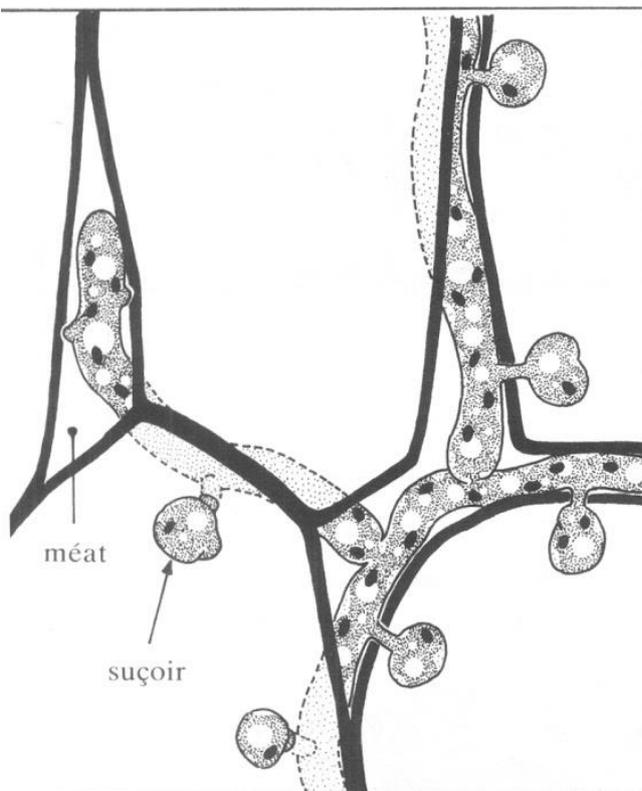
Mycelium grows by extending the tips of the filaments or by creating new cells.



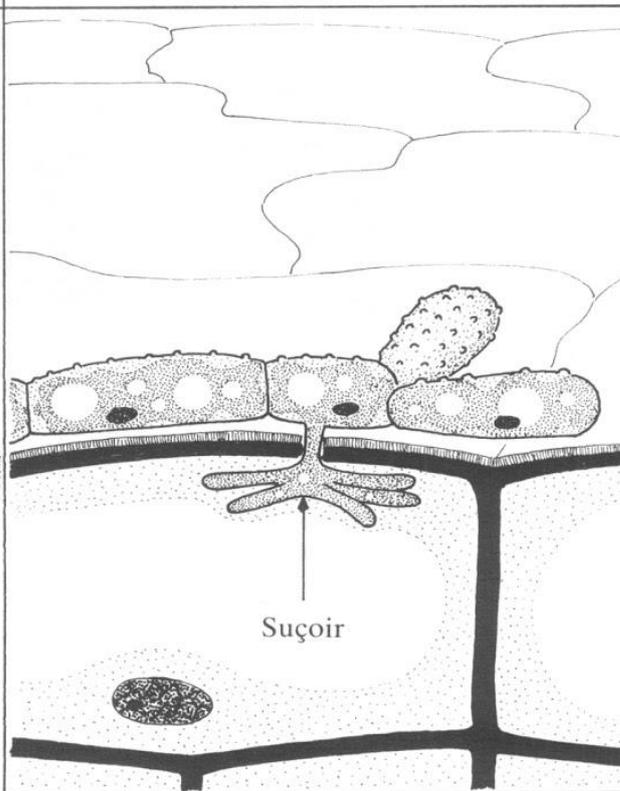
1 Thalle plasmodiale libre
(Phagocytant des débris végétaux)



2 Mycélium de phycomycète (*Pythium*)
Localisation intracellulaire



3 Mycélium de phycomycète (mildiou)
Localisation intercellulaire



4 Mycélium de septomycète (oïdium)
Localisation ectophyte ou ectoparasite

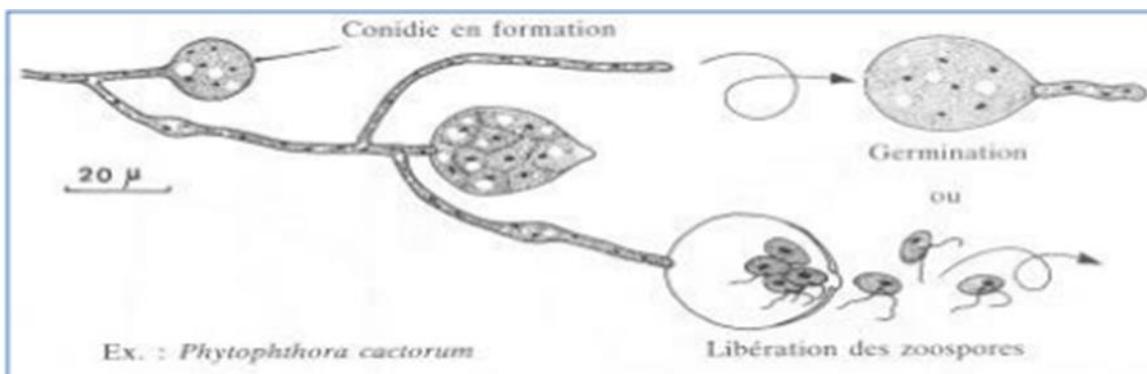


3.2- Fungal reproduction:

Fungi reproduce asexually and sexually.

* Asexual method:

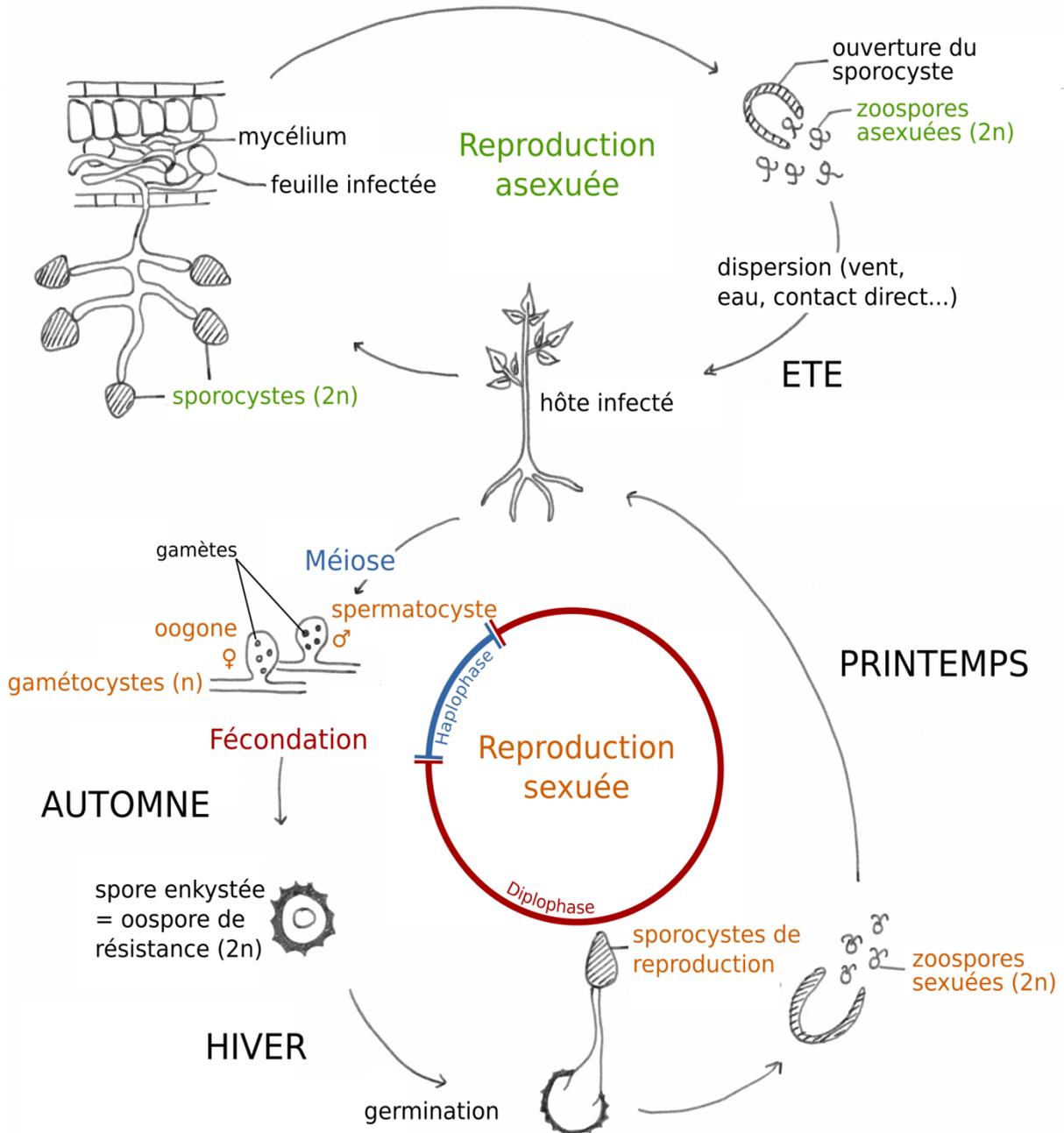
Easily from the parent plant, they are able to establish new colonies if they land on suitable substrates. Conidia separate and are called (spores). Their contents are divided into structures capable of swimming thanks to flagella and can germinate immediately if they find a suitable plant.



Reproduction asexuée : Phycomycètes
Phytophthora cactorum.

*** Sexual method:**

The latter has the ability to produce oospores, which are more complex and consist of the fusion of two sex cells, resulting in an egg containing a spore that can withstand harsh conditions by entering a slow life cycle, but grows again when the right conditions are available, such as heat, humidity, and a suitable nutrient medium.



Life cycle of Phytophthora infestans, the causative agent of potato late blight

1- Temperature:

Although it is not possible to determine the temperature that allows for the optimal development of all fungi, we can observe that medium and high temperatures are suitable for most of them.

2- Humidity:

Fungi require high humidity.

3- Nutrient medium:

If there are few parasitic fungi capable of attacking a large number of plants, then if their chosen host plant becomes extinct, they will not be able to sustain themselves on neighboring plants.

*** Forms of resistance:**

Oospores and conidia - Entering a state of suspended animation

- The walls of the mycelium become thick

- The mycelium takes the form of a ball with a thick, black shell that can remain in a state of suspended animation for a long time.

3.3- Stages of disease development:

a- Dissemination stage:

This stage begins when the spores are released and ends when they reach the host plant. Several factors contribute to the spread of spores, such as wind, irrigation water, insects, humans, and nematodes.

b- Entry stage:

c- Incubation stage:

The period during which the mycelium grows inside the plant tissue without causing obvious symptoms on the plant.

d- Symptom appearance stage:

Symptoms are abnormal morphological changes that affect the external appearance of the plant. These symptoms can have two causes: an imbalance between the aggressiveness of the fungus and the plant's resistance to invasion; this results in the appearance of lesions affecting certain organs, or even the whole plant; yellowing; drying; wilting; leaf fall.

4- Plant pathogenic bacteria

These are bacteria that are pathogenic to plants. They live as parasites on wild or cultivated plants and cause ulcers and rot.

العفن الطري في البطاطس

المسبب : *Erwinia carotovora*



4.1- Bacterial diseases in plants:

*necrosis and burns:

These are localized attacks that lead to the slow death of cells. The leaf shows small spots of dry, dead cells.

***oily spots or soft rot**

The bacterial attack manifests itself in the form of rapid spread that destroys the underlying tissue, and the bacteria multiply in the form of a sticky mass.

***Galls or tumors:**

Uncontrolled proliferation of host plant cells caused by bacteria.

***Tracheobacterioses**

Spread within the conducting tissues of the host plant; leaves wilt on the side of the infected tissue.

***Stages of plant pathogenic bacteria:**

-Pollen storage stage -Infection stage - Spread stage.

5- Plant pathogenic viruses

5.1-Introduction:

Plant viruses have a very simple structure consisting of nucleic acid carrying genetic information within 4 to 12 genes, protected by a protein capsule.

5.2- Characteristics:

Plant viruses have three basic characteristics:

- A. Viruses usually cause diseases that affect all parts of the plant, as they multiply in the roots, stems, and leaves, and only meristematic cells survive.
- B. Viral diseases that affect plants cannot be cured in the field.
- C. Viruses that infect plants are obligate parasites, as they reproduce only in living plants or plant organs, and if the plant dies, they move to a new plant.

5.3- Diseases caused by viruses:

Field crops are exposed to many viruses that attack plants in different ways, resulting in various symptoms such as:

- * **mosaics**
- * **stunting**
- * **yellowing**
- * **necrosis**

These viral diseases are transmitted by direct contact or by seeds or insects such as aphids and whiteflies

.(Pucerons et aleurodes)

5.4- Methods of combating viruses:

- 1- Use virus-free seeds.
- 2- Select resistant varieties.
- 3- Use clean and sterilized tools.
- 4- Clean planting areas by removing diseased plants and weeds.
- 5- Use crop rotation.
- 6- Use insecticides or sticky traps.
- 7- Protect nurseries using insect screens.

5.5- Defense mechanisms in plants:

Plants encounter pathogenic microorganisms such as viruses, bacteria, and fungi, but they effectively resist these attackers.

These substances stimulate the plant's active resistance against attackers. These signaling substances are activated by doses Elicitors There are molecules known as low enough to alert the plant's immune system, triggering resistance. There are two types:

Exogenous elicitors (external) :

They come directly from the aggressor, whether they are molecules found on the surface of pathogenic organisms or secreted by pathogenic organisms.

Endogenous elicitors :

Produced by the plant itself by breaking down the cell wall at the level of the bonds to stimulate defense or cause wound healing.

Defense takes two forms:

* **Passive defense**, i.e., without expending energy, such as mechanical barriers like the cell wall, skin, etc.

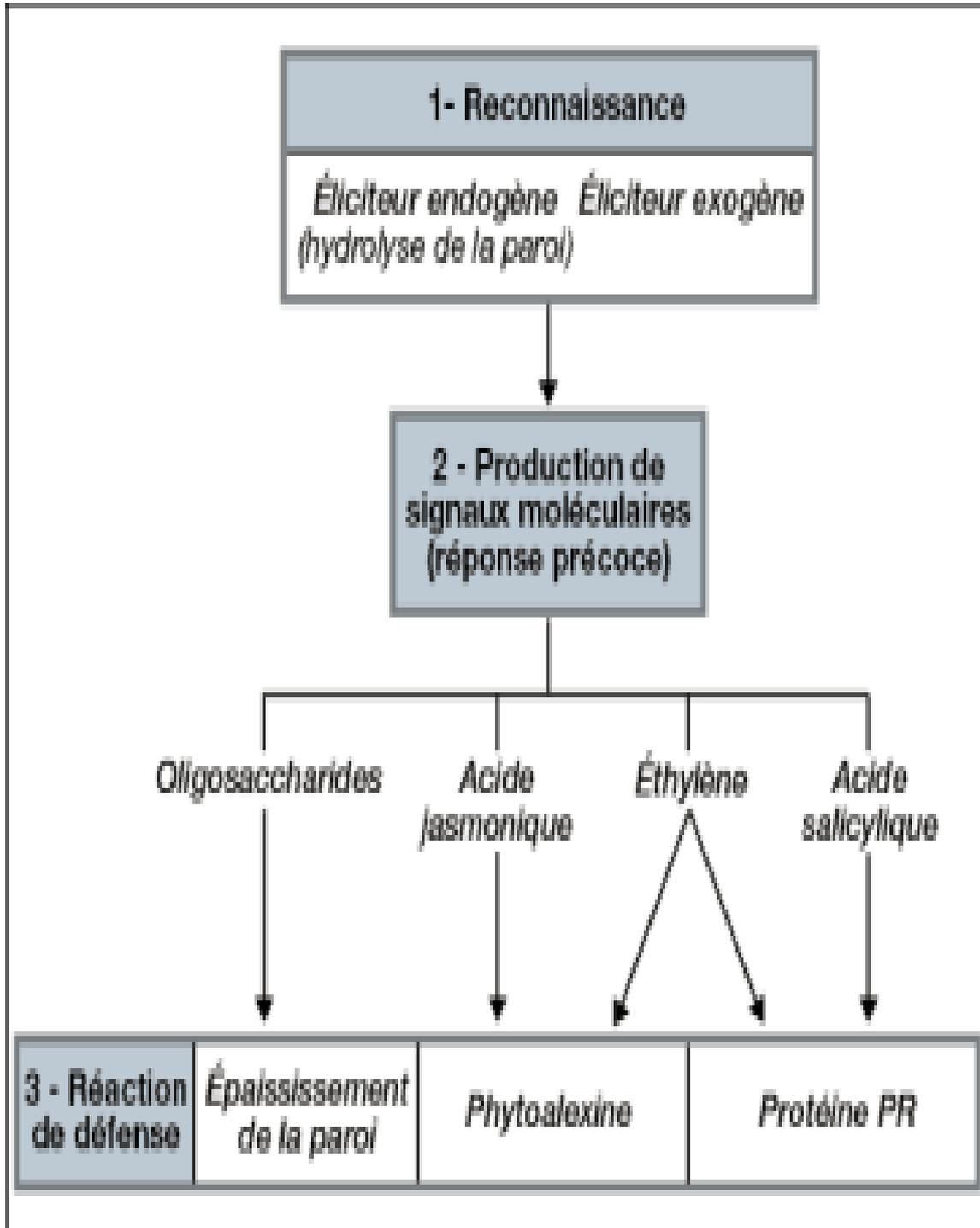
* **Active defense**, which occurs in three stages:

reconnaissance des éliciteurs Stage 1: Recognition of active molecules:

Stage 2: Production of mobile molecules such as:

(oligosaccharides, jasmonic acid, ethylene, salicylic acid).

Stage 3: The defense process:



6- Plant parasitic nematodes (worms)



6.1- Environment and distribution:

Nematodes are active from March to the end of November. All types of plant-pathogenic nematodes usually spend a large part of their lives in the soil, and many of them live freely, feeding on the surfaces of roots and stems growing below the soil surface. Nematodes usually spread in the surface layer of the soil at a depth ranging from 0 to 15 cm, noting that the distribution of nematodes in cultivated soil is irregular, as they spread extensively around the roots of susceptible plants due to the presence of their preferred food, which attracts nematodes through attractants secreted by the host in the soil, especially in the root zone, where the roots secrete certain substances that spread. These substances attract nematodes to the roots and cause infection, and they also activate the hatching of eggs of some nematode species.

In addition, nematodes can spread by any of the known methods of spread, which help to carry particles of contaminated soil from one place to another, as well as through the use of undecomposed organic fertilizer – Planting seedlings contaminated with nematodes – Using irrigation water contaminated with nematodes, as well as agricultural machinery loaded with soil contaminated with nematodes.

Nematodes can protect their eggs and young by

laying eggs in safe places such as flower ovaries, as in the case of wheat nematodes*

laying eggs inside the roots of host plants, as in the case of ulcer nematodes*

laying eggs inside gelatinous substances to protect them from biological enemies and environmental conditions, such as citrus nematodes*

***Keeping eggs inside their bodies after the body turns into a sac containing eggs to protect them from environmental factors and biological enemies, as well as to preserve the vitality of the eggs.**

***Laying eggs in an environment that contains food for the young and subsequent generations so that the young and newly hatched do not have to search for plant hosts.**

6.2- Nematode attack on plants:

Nematodes cause scratches in the roots, but this mechanical damage in itself has a limited effect on the plant. Most of the damage is caused by the saliva that nematodes inject into the plant roots while feeding, which breaks down plant cells and thus makes it easier for nematodes to absorb a large part of the plant cell contents.

Nematodes have the ability to penetrate plant cells and reach the place from which they derive their food. Nematodes have the ability to absorb the contents of plant cells, and they also have a muscular esophagus that acts as a suction pump, helping them to absorb plant sap from the plant and transfer it to their stomach. This feeding process causes plant cells to react by either dying, forming ulcers, or forming swellings and tumors. These symptoms occur as a result of tissue dissolution by nematode enzymes present in saliva.

6.3- Symptoms of nematode infection:

*** Symptoms on foliage:**

Poor foliage growth.

Wilting and stunting of plants.

Yellowing of plant leaves.

Reduced crop yield and quality.

There is a relationship between nematode infection and the occurrence of certain viral diseases such as leaf roll virus and yellow mosaic virus, as in grapes, where infection with these viruses occurs in the presence of nematodes.

Symptoms on the root system: *

Root ulceration.

Root rot.

Excessive root branching.

Abnormal swelling or enlargement at nematode feeding sites (root knots).

There is a relationship between nematodes and fungi that cause wilting diseases, as infection with these pathogens increases in the presence of nematodes.

6.4- Methods of treating nematodes:

***Preventive methods:**

These include agricultural quarantine, planting healthy seedlings, cleaning agricultural tools, removing weeds, and selecting resistant varieties.

***Agricultural methods:**

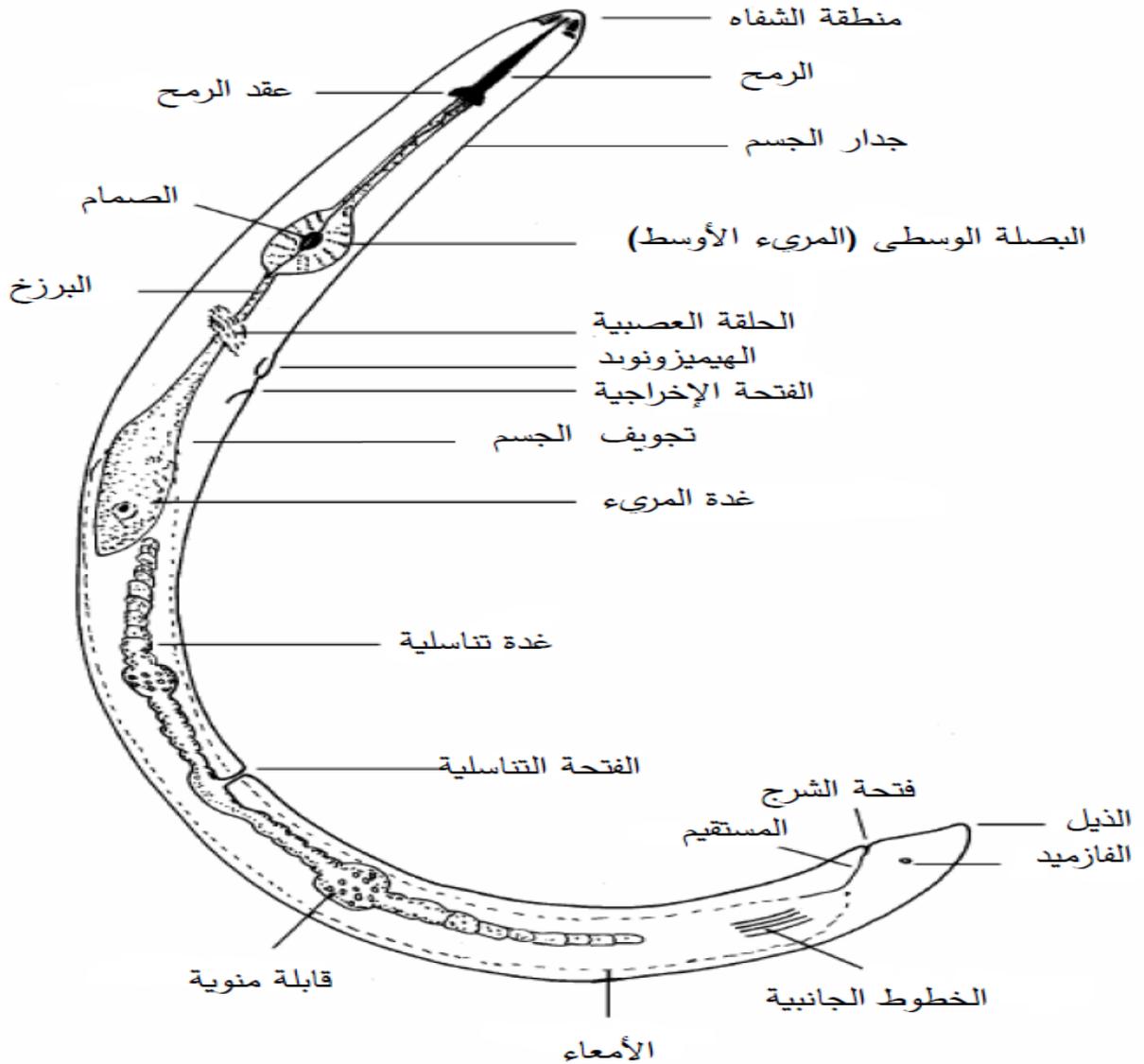
. These include the use of decomposed organic fertilizers and periodic soil tillage.

***Chemical methods:**

These involve the use of nematicides that are safe for plants and humans and more effective against nematodes. One of the most well-known and effective nematicides is Nemafox, which is used at a dose of 3 liters per hectare. It eliminates all types of nematodes in field crops, vegetables, and fruits, working in two ways:

Contact: It kills nematodes upon contact.

Systemic: It is absorbed by the roots and transported to the leaves, where it can eliminate different types of nematodes.



Schematic diagram of a nematode

7. Insect pests:

Insect pests are insects that are harmful to agricultural crops in general.

Pests directly attack plants, eating leaves and leaving holes in stems, fruits, or roots. The damage may be indirect, with the insects themselves causing little or no damage, but they transmit bacterial, viral, or fungal infections to the crop, often spreading diseases from one plant to another unchecked until their numbers multiply. Therefore, effective and professional pest control measures must be taken in all cases to preserve plants and keep them under control and continuous monitoring.

Pest species can also cause significant damage to products ready for sale, which are called stored product insects. These creatures invade grains and goods, causing damage to raw foodstuffs and spoiling finished products. Infestation can render products unfit for human consumption.

7.1- Main species:

***Locusts:**

Well known in agriculture, these pests date back to 2000 BC and caused the destruction of some of the first crops. Nowadays, they still pose a threat to almost all types of plants. When conditions are right, locusts gather in huge swarms (up to 460 square miles in size) and devour the surrounding vegetation. As long as they can eat their weight in plants every day, the destruction to vegetation is enormous.

Control methods:*

New discovery (4V4) Insecticides are known to be the only effective weapon against locust pests. Pheromones are considered

to be the best way to eliminate locusts. Researchers propose using a synthetic version of the scent to attract locusts (as its use harms plants, animals, and humans) to specific locations far away, which are used as traps where they can be controlled.



***Aphids:**

Aphids are among the most harmful insects to agriculture in the world and live in groups.

Aphids damage plants by reducing photosynthetic activity on leaves, which leads to lower fruit quality and quantity, and in some cases may cause plant death.

***Control methods:**

*Inspect the land before planting and remove weeds that can accumulate aphids to prevent them from transferring to crops after they grow.

*Prune large tree branches that provide dense shade, which encourages aphid growth, to make the area less suitable for them.

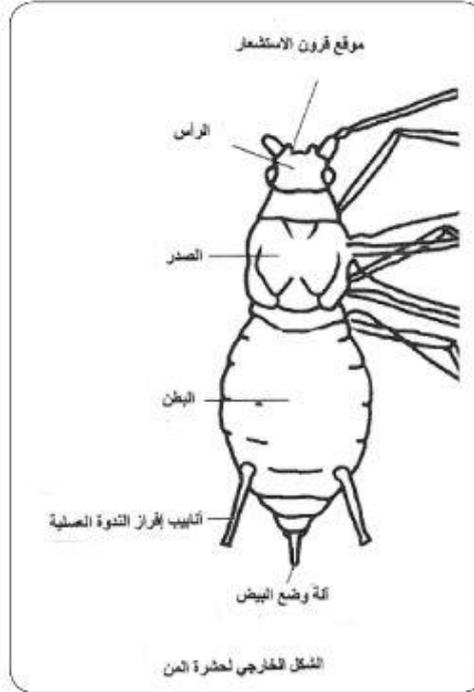
* Wash plants infected with aphids by directing a strong spray of water at them to wash away the honeydew, causing the aphids to fall off and preventing them from climbing back onto the plant.

* Grow seedlings under protective covers in the garden or in greenhouses, as they are vulnerable to severe damage if infected with aphids in the early stages. Once the seedlings become more resilient, they can be moved outside. Protective covers also help prevent the spread of viruses carried by aphids.





أحد أنواع المن يضع البيض



*Snail:

Snails are one of the most deadly pests to various agricultural crops. They are also one of the most difficult agricultural pests to eradicate due to their high resistance to many agricultural pesticides and their rapid reproduction. Snails are hermaphrodites, meaning that all individuals are capable of laying eggs, which contributes to their rapid spread. Snails often need snail with a shell takes longer than a naked snail (slug) to reach maturity.

Snails are nocturnal creatures that are active on cloudy days and during foggy weather, hiding on sunny days because they love moisture. As snails move, they secrete a mucous substance that reduces friction with the surface they are walking on. Once this substance dries, it turns into a shiny silver line, which is one of the most important signs of snail infestation.

It has also been observed that snails often eat plant leaves from the center rather than the edges, as insects do. Snails eat both living plants and dead plant debris, preferring young, tender, succulent plants. They also eat fruits such as strawberries, tomatoes, and and others.

*Control methods:

Avoid planting succulent plants as much as possible and replace them with snail-resistant plants such as geraniums.

In addition, plants with hard leaves, such as palm trees of all kinds, are also recommended.

* Perennials are often more resistant to mollusks than annuals because they contain less liquid than annuals. Thorny plants and plants with a strong aromatic scent, such as geranium, mint, and lavender, are also plants

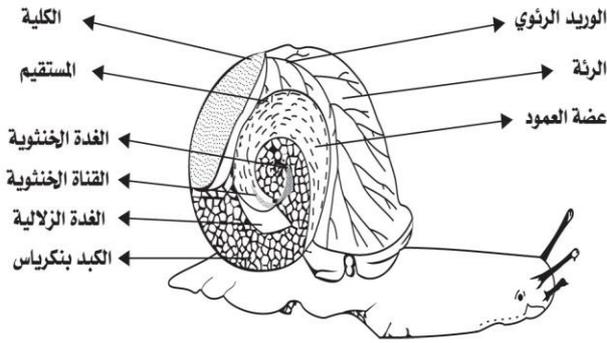
that repel mollusks.

Electric shock to slugs when they walk *Snails also hate sulfur and copper, as copper causes

Therefore, copper chips can be used to protect garden plants from slug attacks.

* Coating tree trunks with a mixture of lime and copper sulfate also prevents slugs from approaching those trees. This mixture is called

Bordeaux mixture.



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*Potato beetle (Colorado beetle):

The potato beetle (Colorado beetle) has been a nuisance due to its resistance to insecticides. In fact, it has developed resistance to more than 50 insecticides in just 50 years, causing significant damage.

They feed on potato crops, but they can also feed on tomatoes and eggplants, as well as on the leaves of vegetable plants.

However, they can also feed on the stems of fruits and vegetables. If left alone, these beetles can destroy entire crops quickly and in a short period of time.



***Control methods:**

Currently, insecticides are used as the primary means of controlling Colorado potato beetles on commercial farms. However, many of the chemicals used have been unsuccessful in controlling Colorado potato beetles due to their ability to evolve rapidly and lay large numbers of eggs.

Chapter II: Methods of Control

Les moyens de lutte

The application of sound and adapted agricultural techniques makes plants more resistant to crop pests.

1-Agricultural method:

*** Solarization:**

This is a non-chemical, environmentally friendly method of pest control that uses solar energy to raise the soil temperature to levels that kill or weaken many soil-borne pathogens that cause plant diseases.

Soil solarization is used in warm climates on a relatively small scale in gardens and organic farms. Soil solarization weakens and kills fungi, bacteria, nematodes, insect pests, and mites. The soil is usually covered with a transparent polyethylene cover to trap solar energy. Soil solarization depends on time, temperature, and soil moisture. This energy causes physical, chemical, and biological changes in the soil community.

*** Plowing:**

Plowing is the breaking up of soil clumps and leveling of the ground, in addition to making furrows, ridges, and basins, designing the garden or field, and dividing it according to the crops to be grown.

Plowing allows the soil to be aerated and weeds to be buried, which compete with crops for food, moisture, and sunlight, as well as increasing the incidence of pests.

A good plowing system helps the soil retain moisture, mechanically crushes some harmful insects, exposes others to natural enemies, and buries some insects deep underground where they cannot escape.

*** Crop rotation:**

The crop rotation cycle contributes to soil treatment and control of pests and plant diseases. It refers to the scientific succession of agricultural crops by changing the type of crop grown on a particular piece of land from season to season, with the aim of reducing the spread of pests, as the cycle interrupts the insect's life cycle before it is complete, thus eliminating the causes of disease.

Calcium amendments:

Calcium amendments allow you to achieve the optimal pH level for cultivated plants and eliminate parasites and weeds.

***Drainage and irrigation:**

These processes allow crops to grow well and prevent the growth of weeds that thrive in high humidity.

2.Genetic methods:

New varieties must be selected that are more productive and of improved quality, as well as more resistant to adverse conditions such as frost, high temperatures, and disease.

3.Physical methods:

Energy is used to destroy, injure, or stress crop pests, or to remove them from the environment. These methods are only used when necessary, such as burning with flamethrowers to destroy locusts, etc.

Use of drip irrigation systems.

Use of cellulose thread nets to trap insects.

Use of bird nets.

4.Mechanical methods:

These are often manual operations such as: collecting insects - removing the bark of fruit trees in winter to eliminate scale insects

- packing fruit - weeding.

5.Psychological methods:

These involve attractants that allow for capture and destruction, or repellents such as:

- Trapping insects with light traps.

- Male insects are attracted to females in a cage.

Deterring pest birds with noise using thunderers.

- Deterring crows by playing a magnetic tape through loudspeakers that produces screams that scare birds away.

6.Biological methods:

These are a set of methods that involve the use of living organisms to reduce the damage caused by other organisms that are harmful to humans, animals, or crops.

Biological control methods include:

The use of predatory insects, birds, and other organisms. *

* The use of parasitic organisms such as bacteria, viruses, and fungi.

* The use of insect sterilization techniques (disabling the reproductive system of one sex to prevent natural fertilization between males and females).

Advantages of biological control

Safe and harmless to humans and the environment

Sustainable, as their numbers reproduce naturally and there is an increase in parasites and predators in the field

Economical, inexpensive compared to other control methods

Easy to apply and does not require a large workforce

*** Biological control against insects:**

The most important examples of biological control:

1. Trichogramma parasite

It is considered one of the most widespread parasites in the field of biological control. It is an internal parasite that grows on the eggs of scale insects, destroying the pest while it is still in the egg stage before it hatches into larvae and causes economic damage.

Advantages of the Trichogramma parasite

- It can be used on many crops such as tomatoes, potatoes, grapes, corn, cotton, olives, palm trees, and all crops that are affected by scale insects.
- It is safe for the environment and does not cause harm to humans or animals.
- It has a high ability to search for hosts.

Economical in terms of time, equipment, and number of workers involved in the release process compared to pesticides. -

Control results sometimes exceed those of pesticides.

The number of parasites on the farm doubles from one generation to the next in a short period of time.

- The pest is eliminated at the egg stage before damage occurs.

7. Chemical methods:

Chemical control is carried out using pesticides, which are any chemical products that may be mixed with other substances and used

as insecticides, fungicides, herbicides, rodenticides, etc., to combat carriers of human or animal diseases.

* Pesticides:

It is a pesticide used against insects at all stages of their growth.

We resort to controlling agricultural pests using chemical pesticides. Some natural plant derivatives were also used, and among the chemical pesticides used was Bordeaux mixture, which consists of copper sulfate, quicklime, and water, as well as preparations containing mercury, lead, and sulfur.

Such pesticides are characterized by their inert residues, which can accumulate in the soil, contaminating it, and then be washed away either by rainfall or

by irrigation, where they are carried to rivers, leading to the death of algae and fish.

*Types of insecticides:

Organochlorine pesticides, or chlorinated hydrocarbons: Such compounds cause significant pollution damage

*to the environment, resulting in poisoning of various living organisms exposed to them, and are therefore described as toxic pollutants. An example of this is pentachlorophenol.

Their use developed in the 1950s.

*Organophosphorus pesticides:

These are now used in greater quantities than organochlorines, even though they are more toxic, because organophosphorus compounds are unstable and therefore do not remain in the environment for long.

They also decompose rapidly in the soil and are fast-acting insecticides with an effective effect on the nervous system.

* Commonly used types of insecticides:

1- Natural organic:

*Nicotine

*Rutonoid

*Pyrethrum

2- Compound organic:

*Drin

DDT*

A- Organic chlorinates:

*Chlordane

*Lindane

B- Organic phosphates:

*Malathion

*Minazone

Herbicides:

As the name suggests, they are used to eliminate weeds that are harmful to agricultural crops.

Selective herbicides control specific types of weeds while leaving the desired crop relatively unaffected.

Weeds are divided into biological groups based on their growth, nutrition, and reproduction, and it is important to be familiar with them in order to determine the correct methods to use in controlling them.

Herbicides differ according to the following:

***According to their mode of action:**

1- Contact action herbicides

2- Systemic action herbicides

***According to when they are used:**

1 Herbicides used before germination.

2 Herbicides used after germination.

Weeds are divided into two groups:

*** Non-parasitic weeds:**

These include annual, winter, and summer perennials, and can be further divided into narrow-leaved and broad-leaved weeds.

***Parasitic weeds:**

Such as: Cuscuta (Dodder) and Orobanche (Broomrape)



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جيبسي



برومبي 80 إي سي



أبيروس



غرانستار 75 دي أف



ريفورمون SL 720



روميتري 480 أس سي



ديلوكسان 36 سي إي



ميتريكسون



فلوراميكس